

# Module 1: Section 1D: A Closer Look at the Standards for Mathematical Content: High School Functions Sample Tasks

## Task 1:

**iM Illustrative Mathematics**

### Pizza Place Promotion

**Task**

In order to gain popularity among students, a new pizza place near school plans to offer a special promotion. The cost of a large pizza (in dollars) at the pizza place as a function of time (measured in days since February 10th) may be described as

$$C(t) = \begin{cases} 9, & 0 \leq t \leq 3 \\ 9 + t, & 3 < t \leq 8 \\ 20, & 8 < t < 28 \end{cases}$$

(Assume  $t$  only takes whole number values.)

a. If you want to give their pizza a try, on what date(s) should you buy a large pizza in order to get the best price?

The best price is on Feb 10, 11, 12, 13

b. How much will a large pizza cost on Feb. 18th?

$9 + 8 = \$17$

$C(\text{Feb. 18th}) = \$17$

c. On what date, if any, will a large pizza cost 13 dollars?

$\$9 \quad 9 + 4 = 13 \quad \text{Feb 4}$

on Feb 14 it will cost \$13

d. Write an expression that describes the sentence "The cost of a large pizza is at least  $A$  dollars  $B$  days into the promotion," using function notation and mathematical symbols only.

Cost  $\geq \$A$  for  $B$  days after Feb 10

e. Calculate  $C(9) - C(8)$  and interpret its meaning in the context of the problem.

$C(9) = 20$        $20 - 17 = 3$

$C(8) = 9 + 8 = 17$       It means pizza cost \$3 more on day 9 than on day 8

f. On average, the cost of a large pizza goes up about 85 cents per day during the first two weeks of the promotion period. Which of the following equations best describes this statement?

•  $\frac{C(13) - C(0)}{13} = 0.85$

•  $\frac{C(13) + C(0)}{2} = 0.85$

2 weeks = 14 days

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

but it should be 14

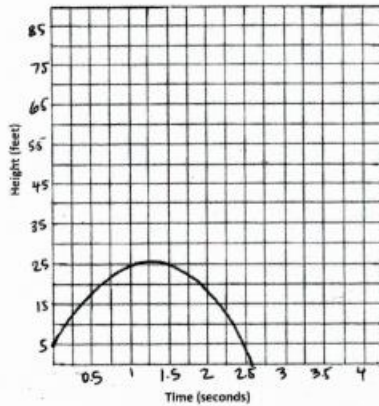
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## Task 2:

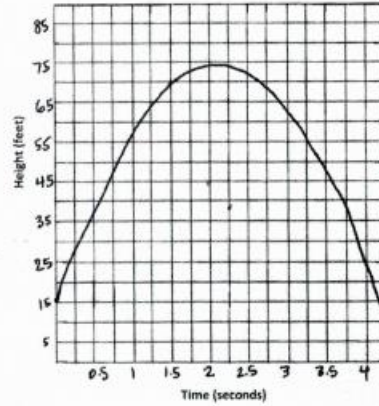
### Cannon Ball!

Three cannons are fired at the same time. The graphs below show the height of the cannon balls from each cannon over time. Answer all of the questions about the cannons below.

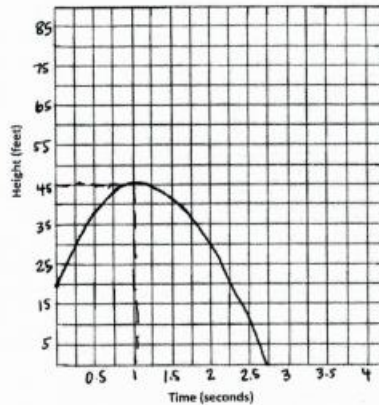
Cannon #1



Cannon #2



Cannon #3



1. Which cannon went highest in the sky? #2
2. Which cannon was in the air for more than 3 seconds?  
#2
3. Which cannon came back down to the ground first?  
#1
4. Which cannon was fired from the highest point on land? #3
5. Which cannon(s) reached a height of at least 30 feet?  
#2 + #3
6. For cannon #3, label the important parts of the graph and explain what they represent in this situation.

vertex:  $(1, 45)$  Domain: all real #s  
 maximum  
 symmetry  $x = 1$  range:  
 x-intercept  $(0, 2.75)$

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### Task 3:

#### Algebra I – Functions

1) Solve for y.

$$y = -3x + 6 \text{ when } x = 2$$

$$\begin{aligned} y &= -3(2) + 6 \\ y &= -6 + 6 \\ \boxed{y} &= \boxed{0} \end{aligned}$$

3) Solve for x.

$$y = 5x - 6 \text{ when } y = -1$$

$$\begin{aligned} -1 &= 5x - 6 \\ +6 & \quad +6 \\ 5 &= 5x \\ \boxed{x} &= \boxed{1} \end{aligned}$$

5) Find k(10).

$$k(n) = 5n - 3$$

$$\begin{aligned} k(10) &= 5(10) - 3 \\ k(10) &= 50 - 3 \\ \boxed{k(10)} &= \boxed{47} \end{aligned}$$

7) Find f(8).

$$f(n) = -n^2 - 3$$

$$\begin{aligned} f(8) &= -(8)^2 - 3 \\ f(8) &= -64 - 3 \\ \boxed{f(8)} &= \boxed{-67} \end{aligned}$$

2) Solve for y.

$$y = -4x - 3 \text{ when } x = -7$$

$$\begin{aligned} y &= -4(-7) - 3 \\ y &= 28 - 3 \\ \boxed{y} &= \boxed{25} \end{aligned}$$

4) Solve for x.

$$y = 7x + 5 \text{ when } y = 47$$

$$\begin{aligned} 47 &= 7x + 5 \\ -5 & \quad -5 \\ 42 &= 7x \\ \boxed{x} &= \boxed{6} \end{aligned}$$

6) Find h(-4).

$$h(n) = 50 - n^2$$

$$\begin{aligned} h(4) &= 50 - (4)^2 \\ h(-4) &= 50 - 16 \\ \boxed{h(-4)} &= \boxed{34} \end{aligned}$$

8) Find w(n/2).

$$w(n) = -4n$$

$$\begin{aligned} w\left(\frac{n}{2}\right) &= -4\left(\frac{n}{2}\right) \\ w\left(\frac{n}{2}\right) &= \frac{-4n}{2} \\ \boxed{w\left(\frac{n}{2}\right)} &= \boxed{-2n} \end{aligned}$$

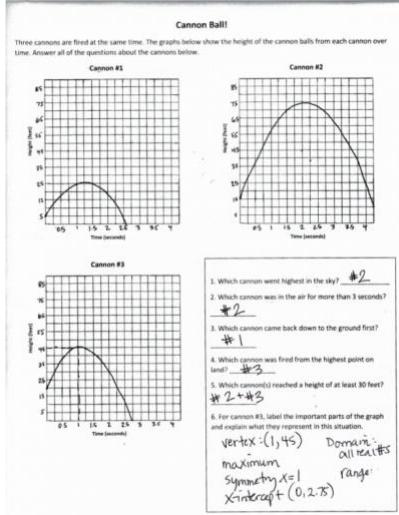
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# Module 1: Section 1D: A Closer Look at the Standards for Mathematical Content: High School Functions Sample Tasks

## Participant Guide

Student Work Sample	Standard of Mathematical Content Focus	Degree of Alignment	Standards of Mathematical Practice (SMP) Focus
<p><b>Sample Task 1:</b></p> <p><b>iM Illustrative Mathematics Pizza Place Promotion</b></p> <p><b>Task</b></p> <p>In order to gain popularity among students, a new pizza place near school plans to offer a special promotion. The cost of a large pizza (in dollars) at the pizza place as a function of time (measured in days since February 10th) may be described as</p> $C(t) = \begin{cases} 9, & 0 \leq t \leq 3 \\ 9 + t, & 3 < t \leq 9 \\ 20, & 8 < t < 28 \end{cases} \quad \begin{matrix} \text{Feb 10, 11, 12, 13} \\ \text{Feb 14, 15, 16, 17, 18} \\ \text{Feb 19 to 28 days later} \end{matrix}$ <p>(Assume <math>t</math> only takes whole number values.)</p> <p>a. If you want to give your pizza a try, on what date(s) should you buy a large pizza in order to get the best price?</p> <p>The best price is on Feb 10, 11, 12, 13</p> <p>b. How much will a large pizza cost on Feb. 18th?</p> <p><math>9 + 8 = \\$17</math>  <math>C(\text{Feb. 18th}) = \\$17</math></p> <p>c. On what date, if any, will a large pizza cost 13 dollars?</p> <p><math>\\$9 \quad 9 + 4 = 13 \quad \text{Feb 4}</math>      On Feb 4 it will cost \$13</p> <p>d. Write an expression that describes the sentence "The cost of a large pizza is at least <math>A</math> dollars <math>B</math> days into the promotion," using function notation and mathematical symbols only.</p> <p>Cost <math>\geq A</math> for <math>B</math> days after Feb 10</p> <p>e. Calculate <math>C(9) - C(3)</math> and interpret its meaning in the context of the problem.</p> <p><math>C(9) = 20</math>      <math>20 - 17 = 3</math>  <math>C(3) = 9 + 8 = 17</math>      It means pizza cost \$3 more on day 9 than on day 8</p> <p>f. On average, the cost of a large pizza goes up about 85 cents per day during the first two weeks of the promotion period. Which of the following equations best describes this statement?</p> <p><math>\frac{C(14) - C(0)}{14} = 0.85</math>      2 weeks = 14 days      but it should be 14      1 2 3 4 5 6 7      8 9 10 11 12 13 14      15 16 17 18 19 20 21      22 23 24 25 26 27 28</p>	<p>Can you identify the targeted content standard(s) for this task?</p>	<ul style="list-style-type: none"> <li>• None/Weak</li> <li>• Partial</li> <li>• Strong</li> </ul>	<p>Can you identify the targeted practice standard(s) for this task?</p>

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Student Work Sample	Standard of Mathematical Content Focus	Degree of Alignment	Standards of Mathematical Practice (SMP) Focus
<p><b>Sample Task 2:</b></p> 	<p>Can you identify the targeted content standard(s) for this task?</p>	<ul style="list-style-type: none"> <li>None/Weak</li> <li>Partial</li> <li>Strong</li> </ul>	<p>Can you identify the targeted practice standard(s) for this task?</p>
<p><b>Sample Task 3:</b></p> <p>Algebra I – Functions</p> <p>1) Solve for y.  <math>y = -3x + 6</math> when <math>x = 2</math>:  <math>y = -3(2) + 6</math>  <math>y = -6 + 6</math>  <math>y = 0</math></p> <p>2) Solve for y.  <math>y = -4x - 3</math> when <math>x = -7</math>:  <math>y = -4(-7) - 3</math>  <math>y = 28 - 3</math>  <math>y = 25</math></p> <p>3) Solve for x.  <math>y = 5x - 6</math> when <math>y = -1</math>:  <math>-1 = 5x - 6</math>  <math>5 = 5x</math>  <math>x = 1</math></p> <p>4) Solve for x.  <math>y = 7x + 5</math> when <math>y = 47</math>:  <math>47 = 7x + 5</math>  <math>42 = 7x</math>  <math>x = 6</math></p> <p>5) Find k(10).  <math>k(n) = 5n - 3</math>  <math>k(10) = 5(10) - 3</math>  <math>k(10) = 50 - 3</math>  <math>k(10) = 47</math></p> <p>6) Find h(-4).  <math>h(n) = 50 - n^2</math>  <math>h(-4) = 50 - (-4)^2</math>  <math>h(-4) = 50 - 16</math>  <math>h(-4) = 34</math></p> <p>7) Find f(8).  <math>f(n) = n^2 - 3</math>  <math>f(8) = (8)^2 - 3</math>  <math>f(8) = 64 - 3</math>  <math>f(8) = 61</math></p> <p>8) Find w(n/2).  <math>w(n) = -4n</math>  <math>w(\frac{n}{2}) = -4(\frac{n}{2})</math>  <math>w(\frac{n}{2}) = -2n</math></p>	<p>Can you identify the targeted content standard(s) for this task?</p>	<ul style="list-style-type: none"> <li>None/Weak</li> <li>Partial</li> <li>Strong</li> </ul>	<p>Can you identify the targeted practice standard(s) for this task?</p>

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## Module 1: Section 1D: A Closer Look at the Standards for Mathematical Content: High School Functions Sample Tasks

### Facilitator's Guide

Throughout facilitation of this activity it will be important to remind participants:

- Use the grade-level overview to determine the relevant cluster(s) to look at more closely
- Questions regarding Standards for Mathematical Practices will only be indicated where specific practices were identified within the source of the task alignment. Additionally, emphasize to participants the statement at the end of each cluster within the *KAS for Mathematics*, “The identified mathematical practices, coherence connections, and clarifications are possible suggestions; however, they are not the only pathways.”

#### **Sample Task 1:**

This assignment is **strongly aligned** to the standards.

#### OVERVIEW

High school students are asked to use a piecewise-defined function representing a real-world scenario to answer questions and solve problems. The assignment is strongly aligned to the standards because it involves an authentic real-world situation and requires students to do grade-appropriate analysis.

#### RELATED STANDARDS

We looked at how well the assignment aligned to the following standard:

**KY.HS.F.1:** Understand properties and key features of functions and the different ways functions can be represented.

**KY.HS.F.1.a:** Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If  $f$  is a function and  $x$  is an element of its domain, then  $f(x)$  denotes the output of  $f$  corresponding to the input  $x$ .

**KY.HS.F.1.b:** Using appropriate function notation, evaluate functions for inputs in their domains and interpret statements that use function notation in terms of a context.

#### WHY IS THIS ASSIGNMENT STRONGLY ALIGNED?

The assignment uses an authentic scenario represented by a piecewise-defined function, a specialty function reserved for high school study. The problems allow students to engage with the function in several ways, including interpreting the quantities and expressions, connecting the mathematics to verbal descriptions, and analyzing and interpreting the function's domain.

Note: If students were asked to graph a piecewise function this task would align to KY.HS.F.4f (+). Plus (+) standards are additional mathematics concepts students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics. Plus (+) standards are not required learning for every Kentucky student.

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Students use equations to model real-world contexts as early as middle school. By high school, both the mathematics and the reasoning should increase in complexity and sophistication, like they do in this assignment. The use of a piecewise-defined function and questions addressing the domain, the mathematical representations, and the average rate of change all ensure that the assignment is appropriate to high school.

### Practice Standards

The connection to a familiar context allows students to engage with [Mathematical Practice Standard #2](#) (“Reason abstractly and quantitatively”). Students mentally convert between the context (for example, “days since February 10”) and the mathematical representations of compound inequalities. They are specifically asked to translate a verbal description into a mathematical expression and are asked to calculate a mathematical expression and interpret its meaning in the context of the problem.

### Sample Task 2:

This assignment is **partially aligned** to the standards.

### OVERVIEW

High school students interpret the values of three quadratic graphs in terms of the real-world context of the trajectory of fired cannon balls over time. The assignment is partially aligned to the standards because it involves high school-appropriate quadratic functions, but it isn’t appropriately complex for high school because students are only asked to match the graphs to simple features rather than interpreting or analyzing the information.

### RELATED STANDARDS

We looked at how well the assignment aligned to the following standard:

**KY.HS.F.1:** Understand properties and key features of functions and the different ways functions can be represented.

**KY.HS.F.1.c:** For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities and sketch graphs showing key features given a verbal description of the relationship.

### WHY IS THIS ASSIGNMENT PARTIALLY ALIGNED?

The first five questions require students to match a quadratic graph to a description. Because the descriptions are simplistic, all three graphs are provided, and the axes are clearly labeled, students don’t need to understand quadratic functions to answer correctly—they just need to know how to read a graph. The complexity level is therefore more appropriate for middle school (such as in [KY.8.F.5](#)) than for high school.

Standard [KY.HS.F.1.c](#) asks students to interpret the key features of a function using its graph and/or table, which requires conceptual understanding. In this assignment, however, the graphs are already interpreted for students and matching the correct graph with the provided description targets procedural skill. To

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target conceptual understanding, the questions could have asked students to describe the differences between the three cannons and to support their responses using information from the provided graphs.

### Practice Standards

These high school functions standards afford students the opportunity to engage with [Mathematical Practice Standard #2](#) (“Reason abstractly and quantitatively”) by making connections between the graph and the real-world scenario, and with [Mathematical Practice Standard #7](#) (“Look for and make use of structure”). With a tighter alignment to the standards, the assignment might support the use of graphing software or calculators to interpret key features of quadratic graphs ([Mathematical Practice Standard #5](#): “Use appropriate tools strategically,”) and use of more precise numerical descriptions of the situation being modeled ([Mathematical Practice Standard #6](#): “Attend to precision”).

### Sample Task 3:

This assignment is **weakly aligned** to the standards.

### OVERVIEW

High school students evaluate functions for specific values of their variable. The assignment is weakly aligned to the standard because the notation, numerical values, and computations required are more closely aligned to middle school expectations. The problems do not provide any context or require students to interpret the statements that use function notation.

### RELATED STANDARDS

We looked at how well the assignment aligned to the following standards:

[KY.HS.F.1](#): Understand properties and key features of functions and the different ways functions can be represented.

[KY.HS.F.1.b](#): Using appropriate function notation, evaluate functions for inputs in their domains and interpret statements that use function notation in terms of a context.

### WHY IS THIS ASSIGNMENT WEAKLY ALIGNED?

Problems #1-4 of this assignment align to eighth grade standard [KY.8.EE.7](#) because they all involve solving linear equations in one variable (x or y). Although problems #5-8 use function notation, which is aligned with standard [KY.HS.F.1.b](#), the numbers and computation are too simple for high school. Positive and negative integers and computation with simple arithmetic and exponents are more appropriate in sixth grade. The assignment would be more closely aligned to high school if the problems involved more complex numbers (such as rational numbers) and computations (such as higher order exponents or complex fractions).

### Practice Standards

The assignment does not support students’ use of any mathematical practice standards. Were the assignment more aligned to [KY.HS.F.1.b](#), students could have the opportunity to engage with [Mathematical Practice Standard #2](#) (“Reason abstractly and quantitatively”). When students “interpret statements that use function notation,” they are also “attending to precision.” Please note that inclusion of these sample tasks does not represent that this task is endorsed by or rejected by the Kentucky Department of Education. Inclusion of these tasks was for the sole purpose of allowing participants the opportunity to investigate the content standards within the *Kentucky Academic Standards for Mathematics* more closely. All tasks were selected from <https://tntp.org/student-work-library>.



function notation in terms of a context,” they have to reason about the values and computations both within the given real-world context and also purely mathematically separate from the context.

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